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(54) Epoxide polymensation reactor

(57) A reactor for use in the continuous synthesis of epoxide resins which occur in the conversion of phenols or halogenated phenols, epichlorohydrin, alkali hydroxide and possibly additives comprises a circular stator 1 and a circular rotor 2 with a driving shaft 2 having surfaces which face each other and with meshing tooth elements 3 which are positioned thereon and which are arranged as toothed circles, the stator 1 being part of a fixed housing surrounding the rotor and the stator having inlets 5, 6 for the starting products, and an outlet 7 for the reaction mixture and a cooling jacket 8 fed through coolant inlets 9.

FIG. 2

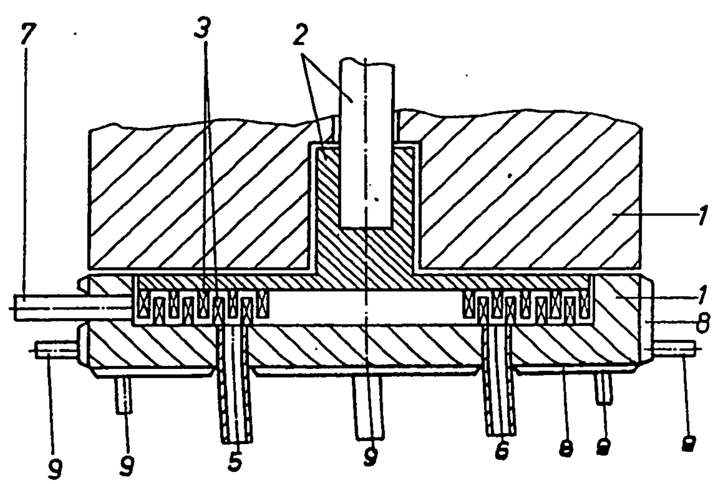

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FIG.1

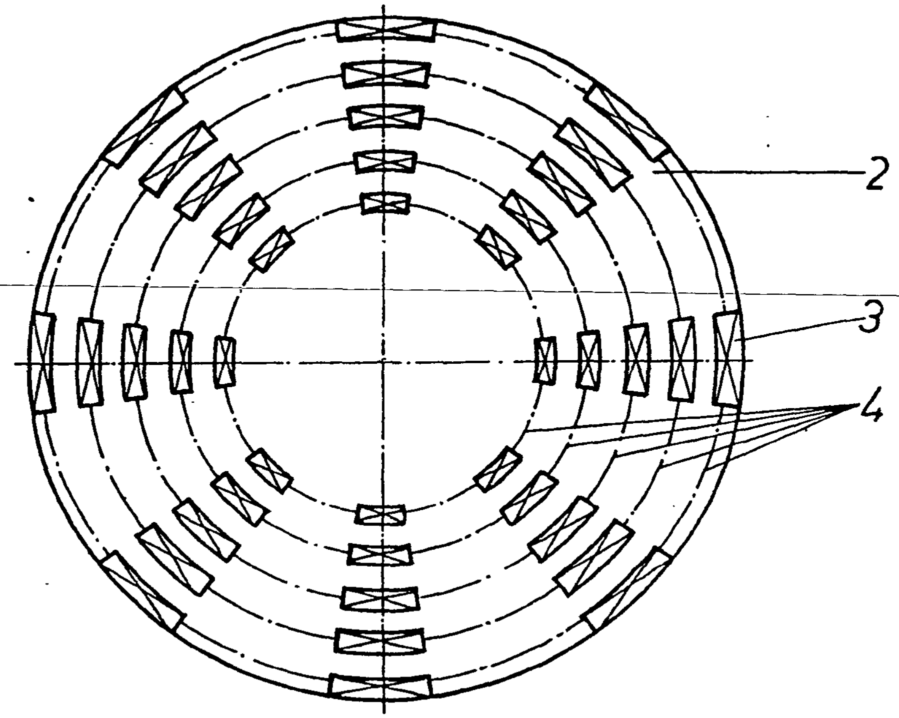

FIG. 2

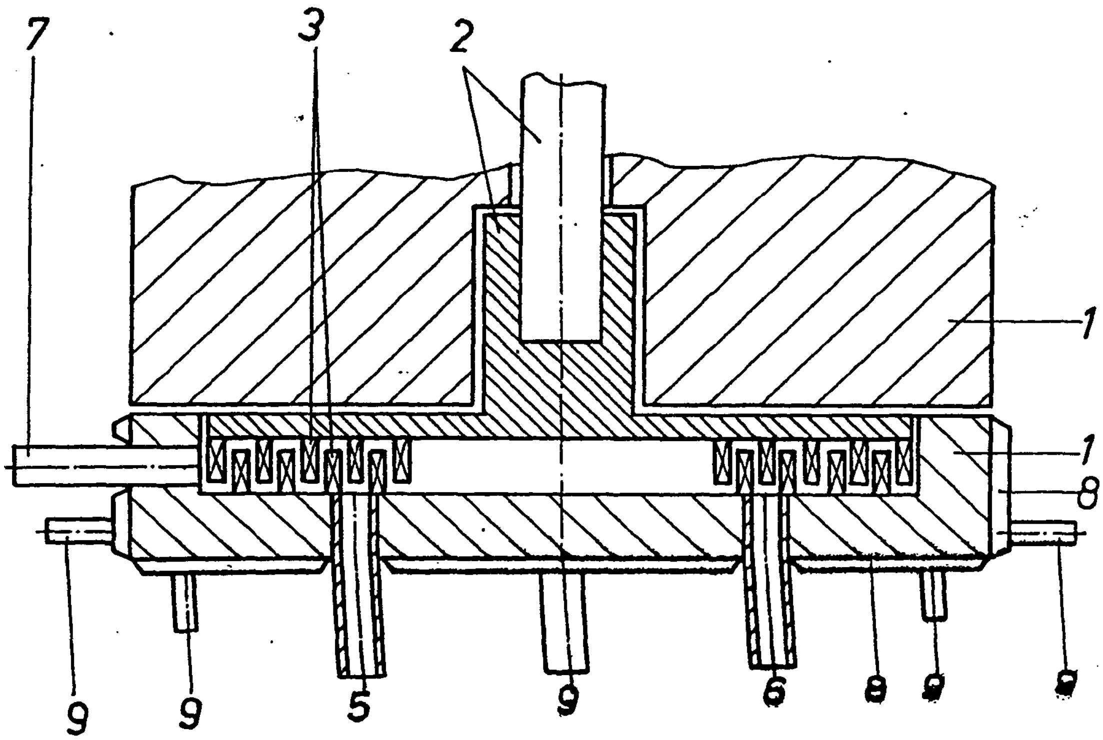

FIG. 3

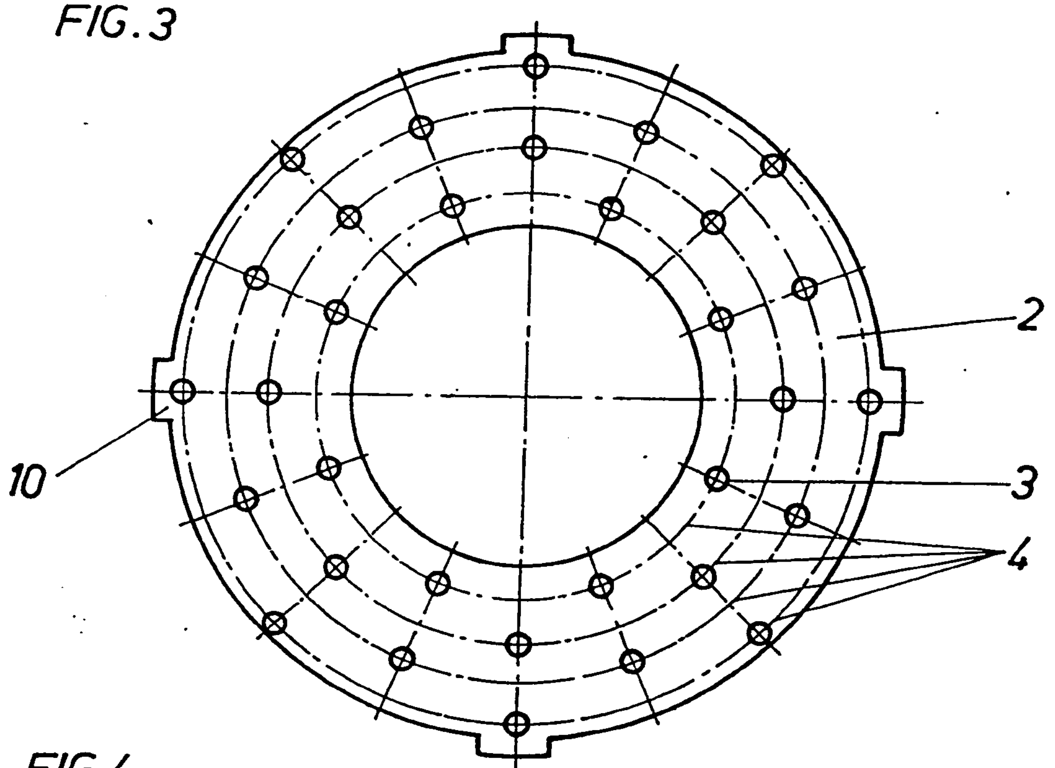

FIG. 4

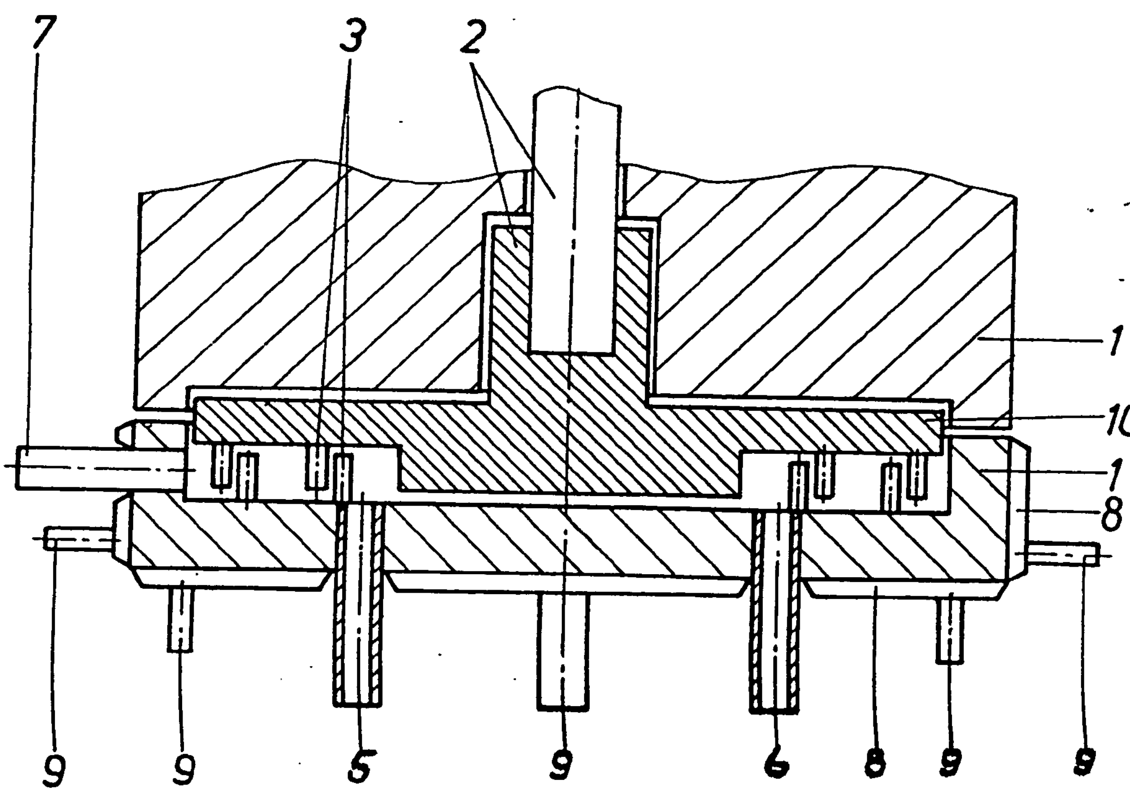

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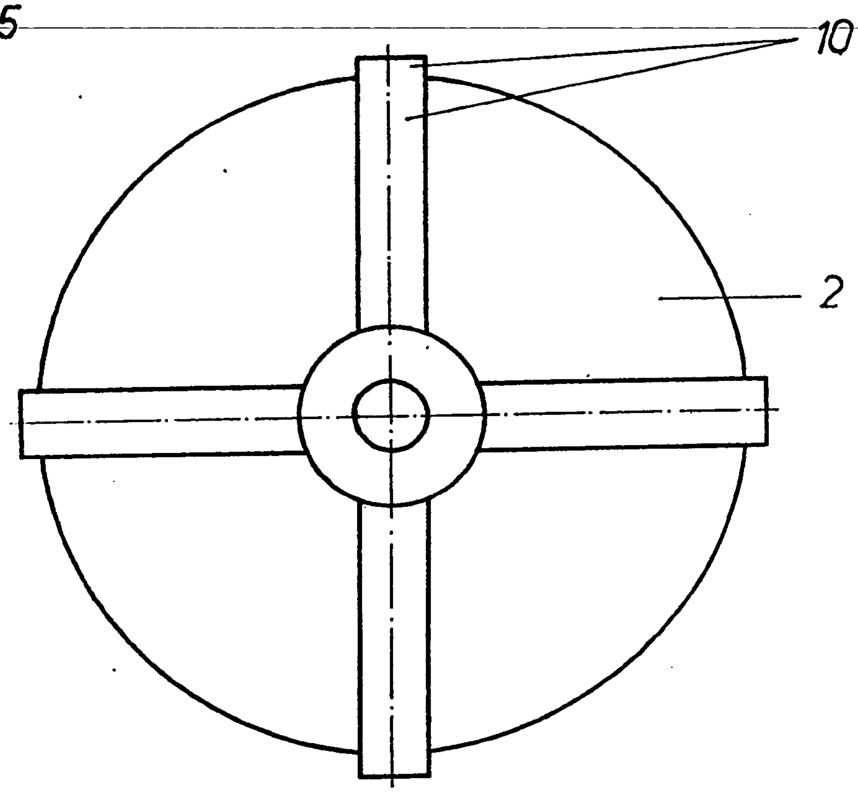
FIG. 5



SPECIFICATION

A reactor primarily for use in the continuous production of epoxide resins

The invention relates to a pressure resistant reactor for use in the continuous synthesis of epoxide resins occurring in the conversion of phenols or halogenated phenols, epichlorohydrin, alkali hydroxide and additives.

Various types of apparatus are known for the continuous production of epoxide resins in which epichlorohydrin, 2,2 - Bis - (4 - hydroxy phenyl) - propane and aqueous sodium hydroxide solution are caused to react.

U.S. specification 2 840 541 describes a process in which resins synthesis is carried out in a number of stages in a stirring cascade. This process involves a very long reaction time, the volumetric yield per unit of time thus being very limited. The use of stirring cascades also results in a number of organic by-products which detract from the quality of the epoxide resin.

U.S. specification 2 986 551 describes a means of avoiding the above drawbacks, using a stirring cascade with 6 reaction stages and with the use of acetone as a solvent. The period of dwell is 3 to 15 minutes per reactor. The caustic soda is added in stages. D.D. patent 137 805 describes a continuous process for the production of epoxide resins with 1 or 2 reactors, a period of dwell of not more than 5 to 10 seconds, a speed of 15 to 50 $m.sec.^{-1}$ and a temperature of 60 to 180°C. This process suffers from the high proportion, i.e. 6 to 10% by mass of monoglycidyl compounds containing hydroxyl groups and the high proportion, monoglycidyl compounds containing hydroxyl groups and the high proportion, amounting to 12 to 18% by mass, of saponification products resulting from the diglycidyl ethers. This combination of the epoxide resin worsens the serviceability properties of the final product and has a disadvantageous effect on the specific consumption of the starting products.

This invention seeks to provide an epoxide resin reactor in which epoxide resins can be continuously produced with an epoxide equivalent of 170 to 4000, a high volumetric yield per unit of time and with constant quality.

According to this invention there is provided a reactor for the continuous production of epoxide resins by the conversion of liquid starting constituents, such as epichlorohydrin, phenols or halogenated phenols, alkali hydroxide and possibly with additives, the reactor being pressure resistant and having a circular stator (1) and a circular driven rotor (2) having mutually facing surfaces each with intermeshing tooth lements (3) arranged in concentric toothed circles, (4) surrounding the stator (1) having inlets (5, 6) and an outlet (7).

The rotor and the stator may each contain from two to eight and preferably from three to five toothed circles, the inner toothed circle of the stator being situated between the first and the second t thed rim of the rotor, which is clos st th axis, th teeth of the toothed circles being of parallelopipedal or cylindrical shape. The inner t othed circl of th rotor, however, can equally w ll be situated betwe n the first and th second toothed rim of the stator, which are close to the axis. The teeth of the stator and of the rotor may be of prismatic shape, the teeth of the stator and of the rotor can also be staggered in position from one toothed rim to the next.

An outlet element is advantageously provided peripherally on the stator, while a number of inlets corresponding to the number of constituents lead axially between the first and the second inner toothed rim of the stator. A number of stripping ridges, two to eight and preferably three to six may be positioned radially on the surface of the rotor which is farther away from the stator, while two to eight and preferably three to five stripping ridges may likewise be positioned on the cylindrical outer surface of the rotor. The cooling is preferably effected by means of a cooling device in the form of a cooling jacket on the stator, including the connections for the coolant.

The reactor to which the invention relates serves for the conversion of phenols or halogenated phenols, epichlorohydrin, alkali hydroxide and possibly additives into epoxide resin reaction mixtures in which the proportion of epoxide resin constitutes an epoxide equivalent of 170 to 4000.

If necessary a number of reactors can be connected up in succession to one another, the first reactor having a cavity inside the inner toothed circle, between the rotor and the stator, while the subsequent reactor or reactors have a rotor filled in as far as the inner toothed circle of the stator and up to the level of the height of the teeth.

The reactors to which the invention relates enables epoxide resin to be produced with a high volumetric yield per unit of time and in an apparatus involving only moderate investment costs and occupying a small amount of space.

The invention is further described and illustrated with reference to the accompanying drawings showing embodiments by way of Examples. In the drawings:—

Figure 1 shows the rotor of a first embodiment of reactor in plan view,

Figure 2 shows in sectional view the reactor of the first embodiment,

Figure 3 shows the rotor of a second embodiment of reactor in plan view,

Figure 4 shows in sectional view the reactor of a second embodiment, and

Figure 5 shows the rotor of Figure 3 in opposite side plan view.

In the drawings:

Figures 1 and 2 show an embodiment with approximately parallelpipedal tooth elements, Figure 1 shows a plan view f the rotor and Figure 2 a longitudinal section through an poxide resin reactor. The expode r sin reactor, of pressure-resistant construction, comprises a circular stator 1 and a circular rotor with a driving shaft 2, having surfaces which fac each other and which carry tooth elements 3 situated in four concentric circles on the stator 1 and in five concentric circl s on th rotor 2. Feeds 5 and 6 for the introduction of the liquid initial constituents

lead in between the first and second toothed rims of the stator 1, which ar closest to the c ntral axis. A discharg outlet 7 is positioned at the periph ry of th stator 1. A cooling jacket 8 with connections 9 for the coolant is mounted around the stator 1.

The liquid starting constituents continuously flow under pressure through the inlets between the first and second inner toothed circles of the stator 1 into the reactor, are carried along by the rotary movement of the tooth elements 3 of the rotor 2, flung outwards by centrifugal forces, deflected by the tooth elements 3 of the stator 1 and intensively mixed thereby, reacting with one another to form epoxide resin. The heat of reaction is removed by the reaction product leaving the reactor and by the coolant flowing through the cooling jacket 8.

This epoxide resin reactor enables epoxide resins of constant quality to be produced continuously with an epoxide resin equivalent of 170 to 1400, with a high volumetric yield per unit of time.

Another embodiment is shown in Figures 3, 4 and 5. In this example Figure 3 is a plan view of the rotor, Figure 4 a longitudinal section through the epoxide resin reactor and Figure 5 is a rear view of the rotor.

This reactor has a circular stator 1 and a circular rotor with a driving shaft 2, having surfaces which face towards each other and which carry tooth elements 3 staggered in position and taking the form of concentric toothed circles 4, the stator 1 and the rotor 2 each contain four toothed circles. The inner toothed circle 4 of the rotor 2 is positioned between the first and second toothed circles of the stator 1, which are close to the axis. The rotor 2 is designed to extend as far as the inner toothed circle of the stator 1, in accordance with the height of the tooth elements.

That surface of the rotor 2 which faces away from the stator 1 carries four stripping ridges 10 mounted radially, another four being mounted radially on the cylindrical peripheral outer surface of the rotor 2.

An inlet 5 for the introduction of the reaction mixture and an inlet 6 for the introduction of the additive feed between the first and second toothed circle of the stator 1, which are closest to the axis. A outlet 7 is mounted on the periphery of the stator 1. A cooling jacket 8 with five connections 9 for coolant is mounted around the stator 1.

The epoxide resin reaction mixture continuously flows under pressure through the inlet 5 between the first and second toothed circles of the stator 1 into the reactor, is carried along by the rotary movement of the tooth elements 3 of the rotor 2, flung outwards by the centrifugal forces, deflected by the tooth elements 3 of the stator and intensively mixed thereby, reacting in such a way as to be completely converted into epoxide resin. At the same time additive is continuously injected under pressure through the inlet 6. Th ep xide resin r action mixture is remov d by the stripping ridges 10 from the surfac s of the stator 1 which are situated opposite them. The reaction heat is removed both by the reaction product leaving the react r and by th coolant flowing through the cooling jacket 8.

This form of reactor is mainly used as a second or additional reactor, also known as an after-reactor.

This epoxide resin reactor enables epoxide resins of constant quality to be continuously produced with an epoxid r sin equivalent of 170 t 4000 and with a high volumetric yield per unit of time.

CLAIMS

1. A reactor for the continuous production of epoxide resins by the conversion of liquid starting constituents, such as epichlorohydrin, phenols or halogenated phenols, alkali hydroxide and possibly with additives, the reactor being pressure-resistant and having a circular stator (1) and a circular driven rotor (2) having mutually facing surfaces each with intermeshing tooth elements (3) arranged in concentric toothed circles, (4) surrounding the stator (1) having inlets (5, 6) and an outlet (7).

2. A reactor in accordance with Claim 1, wherein the stator has a cooling means.

3. A reactor in accordance with Claim 1 or 2, wherein the rotor (2) and the stator (1) each have two to eight toothed circles (4), the innermost toothed circle of the stator (1) being positioned between the first and second toothed circles (4) of the rotor (2), which are nearest the rotational axis.

4. A reactor in accordance with Claim 1 or 2, wherein the rotor (2) and the stator (1) each have two to eight toothed circles (4), the innermost toothed circle of the rotor (2) being positioned between the first and second toothed circles (4) of the stator (1) which are nearest the rotational axis.

5. A reactor in accordance with Claim 4, wherein the number of toothed circles is between 3 and 5.

6. A reactor in accordance with any preceding claim 1 to 3, wherein the tooth elements (3) of the stator (1) and of the rotor (2) are of approximately parallelopipedal or cylindrical shape.

7. A reactor in accordance with any preceding claim, wherein the tooth elements (3) of the stator (1) and the rotor (2) are prismatic in shape and the tooth elements (3) of the stator (1) and of the rotor (2) are staggered in position between one toothed circle (4) and the next toothed circle (4).

8. A reactor in accordance with any preceding Claim wherein an outlet (7) is mounted peripherally on the stator (1).

9. A reactor in accordance with any preceding claim, wherein a number of inlets (5, 6) corresponding to the number of constituents, are mounted between the first and second innermost toothed circle of the stator (1).

10. A reactor in accordance with any preceding claim, wherein the surface of the rotor (2) which faces away from the stator (1) has two to eight radial ridges (10), the cylindrical peripheral outer surface of the rotor (2) having two to eight projections (10) axially mounted thereon.

11. A reactor in accordance with any preceding claim, wherein the stator (1) has a cooling means in the form of a co ling jacket (8) including c nnections (9) for coolant medium.

12. A r actor in accordance with any pr ceding claim, wherein the rotor includes a c ntral portion having a height corresponding to the h ight of the teeth and extending radially to be adjacent the inn rmost t othed circle.

13. A reactor as h rein d scribed with reference

to Figures 1 and 2 or Figur s 3 to 5 of th drawings.

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